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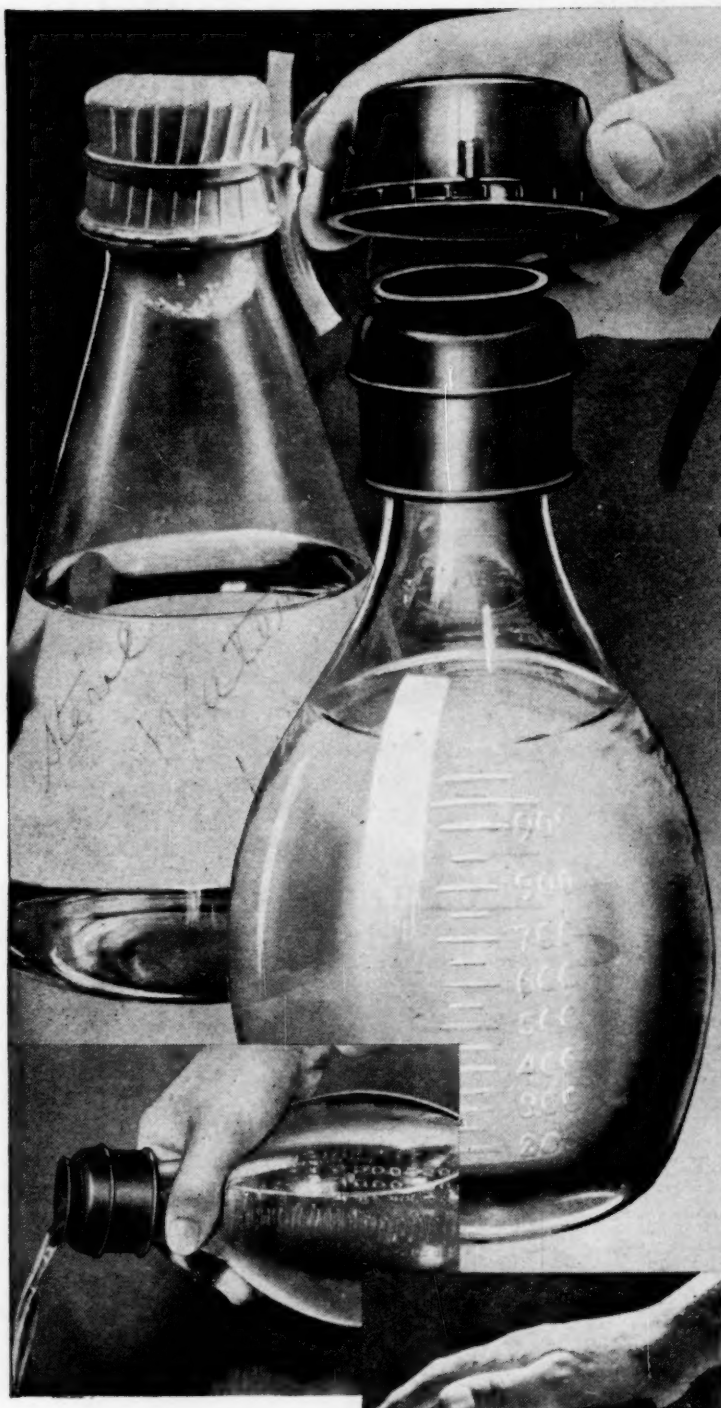

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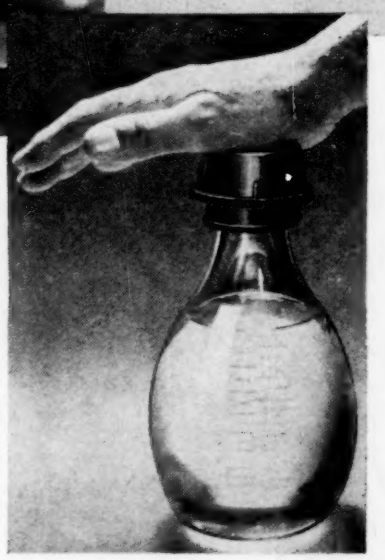

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SCIENCE

Vol. 104, No. 2697 Friday, 6 September 1946

Acceleration: Disgrace or Challenge?

S. L. Pressey

The Ohio State University, Columbus, Ohio

MARVELOUS TECHNOLOGICAL ADVANCES in industry, promising enrichment of American life, were achieved during the war by the united efforts of physicists, chemists, and engineers. For a brief period at the beginning of the war American higher education seemed also on the way toward notable breaks with tradition and gains in efficiency, but the early promise is unrealized. A lengthened school year was so generally the one mthod of increasing educational production that to most people now acceleration unfortunately means only calendar change. Better methods are neglected. It is as though American industry had tried to meet war needs merely by lengthening the work year! Little wonder that now college faculties, wearied by overwork and dubious of such an expedient, are urging return to the "normalcy" of prewar programs.

But at just this juncture these institutions, still short of staff and facilities, face an unprecedented flood of students; moreover, great numbers of them are older and eager to complete their education quickly. Sound means of acceleration seem needed as never before. Also, these older students make insistent the question as to how far into the adult years higher and professional education should extend. The purpose of this paper is to consider briefly whether psychology and scientific education may not be in a position to offer very important and timely evidence regarding (a) the desirable limits of such extension and (b) means of facilitating the educational process, if such means appear needed. The challenge is to educational enterprise and resourcefulness. It seems hardly too much to say that failure a second time to meet this need would be little short of disgraceful.

Desirable Ages for Completion of Higher Education

The conventional age at which the American child enters school is six, or shortly before the sixth birthday. Now almost everywhere elementary and secondary education total 12 years; collegiate programs, 4. As a result of inertia and agitation against acceleration, few students before the war moved more rapidly than the lockstep rate of a grade a year, bringing college graduation most commonly at 22 or less often at 21—at The Ohio State University, for example, only 4 per cent graduated under 21. Further, the number taking graduate or professional training very rapidly increased, making completion of training for these individuals yet later. Thus, the prewar median age at which the doctorate was received in American universities was 32. In contrast, the median age at which this degree was received in German universities, in the golden age of German science before 1914, was 24—a result chiefly of the shorter German program of general education (*5*).

Agitation for earlier completion of training goes back at least 60 years to President Elliott, of Harvard. Thirty-five years ago President Lowell (*3*) returned to the issue with a statement of notable vigor and clarity:

> With the long period of special training now required in every profession, there is a universal cry that men are beginning their careers in life too old, and that the period of education is too long. Disease and death are not postponed because a man starts upon the practice of his profession a year or two later than is necessary. His period of active life, his achievements and his usefulness are simply curtailed to that extent. . . . Much has been said about maturity, but that is the result less of age than of environment and responsibility. Maturity may easily become overripe (pp. 255–256).

Surely, with the present great numbers of older students this problem now presses as never before.

The first issue is that of relations of age to success in college. Studies at Harvard, Columbia, Dartmouth, and elsewhere, going back over 30 years, were in general agreement that the younger student did the best academic work, least often presented disciplinary problems, and participated normally in student life. The issue suddenly assumed special importance at the

Presidential address delivered at St. Louis, 28 March 1946, before the Midwestern Psychological Association, meeting in collaboration with Sections I and Q, AAAS.

beginning of the war because of efforts to bring about college entrance at an earlier age for young men about to be drafted. Extensive study of the problem, then begun at The Ohio State University, was fully in agreement with these earlier findings. It was found that younger entrants were more likely to graduate and that younger graduates had the best academic record. Moreover, statistical analyses indicated that although the younger students averaged brightest as shown by the test of general ability given at entrance, superior ability seemed not the only factor; and many very bright students who might presumably have finished their schooling young did not do so. Further, the accelerates as a group were not socially maladjusted: they took part in more activities than did the older students and rated highest on questionnaires regarding health and emotional adjustment. Where maladjustment was found, it appeared usually avoidable with better selection and guidance and particularly if the educational lockstep and rigid grade stratification both academically and socially, from the first grade through high school and indeed college, could be broken up, acceleration thus becoming more common and more socially accepted. The underage student who was intellectually and emotionally distressingly immature was also much more rare than was often supposed; but usually overlooked were the far more numerous able youngsters who were held back to the lockstep pace and had to "adjust their stride . . . to colleagues inferior to themselves . . . and mark time academically until the calendar should release them" (*2*, pp. 23–26). Practically all the investigations agreed that not the younger, but the older, students did poorly academically and fitted college life least well. Does the record of the returned veteran contradict this last conclusion? He is a special case, his maturity and wide knowledge gained at tragic cost. And possible effects of late completion of education upon adult career should here especially be considered. This issue must now be turned to.

It is frequently argued that even though younger students do well in school, they do not in adult careers, because they are maladjusted or initially too immature. This problem has been studied less, although it was known that highly successful alumni had tended to graduate younger than average. Three exploratory investigations were therefore made. The first, based on the very complete alumni records of an eastern college, involved careful appraisal of the careers of 924 American-born graduates between 1880 and 1900 who lived to be 50 or over. The proportion nationally known decreased strikingly from 29 per cent graduating at 19, to none graduating over 26, and failures were most common among the older, not the younger, graduates. Comparative evidence indicated that superior ability of the younger was probably not the sole determining factor. A second study by Marie A. Flesher, reported in the *Educational Research Bulletin* (1945), compared alumni of 15 years ago of the College of Education, The Ohio State University, graduating at 20 or younger, with classmates graduating at 22 and paired with the younger as to ability on the entrance test and academic record at graduation. This again showed the younger to be the more successful as indicated by salaries and professional status. A third investigation compared two groups of famous Americans, one born about 120 and the other about 60 years ago. Members of the latter group finished their education over two years older *and* attained their first outstanding accomplishment also two years later, while many of the earlier group did notably at ages now usually spent in college (*4*). Although the factors involved in the above studies are exceedingly complex and although the first and third lack controls, the evidence is consistent that early completion of education is not a handicap to a later career but rather is associated with success, and that notable accomplishment may come at ages now commonly pre-empted by full-time education. There is also evidence that prolonging full-time education delays marriage and may be a factor in the low birth rate in the case of parents with college or professional training.

Progress through educational programs at ages earlier than those conventional before the war thus appears to bring greater success for many students both in school and after. Why? A first factor is well established. Individual differences in abilities are so great, and many very superior youngsters mature intellectually (and in many cases also physically and emotionally) so early, that the educational lockstep retards them seriously. For instance, the Carnegie-Pennsylvania studies showed 14 per cent of the 17-year-old high school seniors scoring above the college senior mean on a comprehensive test battery supposedly covering the essentials of a college education (*2*).

A second factor has yet to be adequately studied. However, there is evidence to suggest that the most rapid and marked physical changes in the entire life span occur at around 18 to 20 years of age, when maturity is reached, and that there are then concomitant changes in personality, including a decrease in the exuberance of free-ranging interests needed to give vitality to general education and increased urge for socioeconomic and intellectual independence, marriage and the beginning of a life career. Much subsequent delay in realization of these urges, because of continuing school, might be psychobiologically unhealthy.

Regarding the third factor there is much evidence. Curves showing changes in morbidity and mortality, strength and quickness, and competence in sports throughout the life span indicate the physical peak to be in the late teens and twenties with a decline thereafter, at first slow but later more rapid. Other things being anywhere nearly equal, it would seem desirable that an individual should begin his life work, and more generally his total adult life experience including marriage and establishment of his independent adult career, in this period of greatest physical health and vigor. Moreover, the physical prime should indicate something about the period of the prime in total organic development, including also intellectual vigor and capacity for accomplishment. Roughly, this seems to be so. Tests of "mental alertness" given through the adult years show the peak in the late teens or early twenties. Greatest enthusiasm and devotion to a cause seems to come most often in the twenties, with a setting back to more sedentary interests with middle and later adult years. The notable studies of Dr. Lehman regarding age of greatest accomplishment of famous men in creative work show the peak in the late twenties and early and middle thirties. Urgency is thus given to Lowell's argument: this period of greatest creative potentiality clearly is not postponed because man starts late upon the practice of his profession and may be heavily invaded by undue prolongation of full-time education.

Evidence regarding success both in and after college and regarding individual differences, development, and change throughout the life span thus seems to argue for earlier completion of full-time education than was usual before the war, to point to the need of acceleration for those whose education has been interrupted by the war, and warrant consideration in discussions of required military training. But are there satisfactory means by which individuals or groups may move through educational programs more rapidly than the conventional rate?

Results and Means of Educational Time-Saving

First it must be recognized that efforts to shorten educational programs also have a long history. At least two northern cities as well as numerous southern communities have had 11 instead of 12 elementary and secondary precollege years. When students from such 11-year programs went on to college, most evidence seems to be that at least by the senior year they did as well as students from 12-year college preparatory programs. Most of the considerable number of careful experiments regarding the acceleration of superior children have been favorable. One group, for example, did three years of junior high school in two years. Both the tests given at the end of the three-in-two program and academic records in the following school year showed practically no loss as compared with students of equal ability who took the usual three years. There was very little social maladjustment; in fact, gains in maturity were reported.

Efforts to shorten college programs also go back 75 years (*1*), when completion of general education at the end of the sophomore year was widely discussed. Present programs at Stevens College and the University of Chicago are not new in this respect. Efforts to shorten the four-year program to three were made at Harvard, Cornell, and Johns Hopkins; Clark had such a program for 20 years. A general attempt to shorten college programs seems to have come, however, only with the recent war.

The Ohio State University has for almost 25 years been on the quarter plan and therefore more flexible in its programs than many institutions. Yet in the essentially prewar graduating class of 1941–42 in the colleges of Agriculture, Arts, Commerce, and Education only 3 per cent of the students who had all their college work in this institution took less than the conventional time (the fourth June after entrance or equivalent total of three years, nine months, over-all elapsed time), and only 1 per cent finished in three years or less. However, in 1944–45 the accelerates increased to 35 per cent, with 22 per cent finishing in three years or less.

How did these accelerates make out? In the above-mentioned undergraduate programs, and with acceleration and its amount optional, most did well. (In difficult technical curricula such as medicine, and where acceleration is required of every student, the situation and the outcomes are different.) In a typical study, 76 women in the above-mentioned colleges who attained a degree in three years or less were paired with others who had taken the regular time, entered at the same age, and had the same score on the entrance test of general ability. The final academic record of the accelerates was found actually to be somewhat higher than that of the paired cases, presumably as a result of stronger motivation and better study habits. Both groups were decidedly superior to the average student (accelerate point-hour ratio, 3.06; controls, 2.78; average for all women, 2.71). Moreover, the accelerates were almost as active in student affairs as the paired cases and more so than the average student, in spite of the fact that activities are, in great part, organized on a three-quarter, four-year basis. The accelerates were interviewed and also filled out certain questionnaires and check lists. A few cases complained of the burden of the accelerated program or appeared to have attempted beyond ability or energy, but most of

these were also earning their way or had emotional problems usually connected with the war. The majority of the accelerates showed no unfortunate outcomes. It was also found that students who began an accelerated program were more likely to stay with it and graduate than those moving at the conventional pace. In short, the conventional rate in the usual undergraduate program appeared set for the average or below-average student, and a faster pace seemed normal for the more able.

This acceleration was, however, gained mostly by four-quarter attendance and next by heavy course loads—two very clumsy methods tantamount to lengthening of the work year or overtime in a factory. Although many students took all this in stride, others complained. Might not methods be used which, like technological advances in industry, would *save* time and labor for both students and faculty? Two very simple investigations will illustrate two possibilities. The first concerned credit by examination in chemistry. At the start of the quarter, students in the beginning course took a placement test, those scoring approximately in the upper 5 per cent receiving credit by examination for the first course and moving into the next. It was found that of 365 students who in the past six years had received examination credit 51 per cent had made A, 30 per cent had made B, and only 1 per cent failed in the second course; but of 904 students who had actually taken the previous course, 8 per cent made A and 20 per cent B, while 11 per cent had failed. Students scoring just below the critical point for giving examination credit for the most part also did very well in the second course. It was concluded that the number given examination credit might be increased, and that if a brief statement regarding the content of the first course and the nature of the examination were made available to entering students and high school teachers, good students might be so aided in preparation for the examination that the number might be increased still further. Such a step would encourage good students, move them through the university faster (and thus relieve congestion as to housing, classroom space, and staff), stimulate high school teachers to help good students, and more generally encourage good high school teaching. If the same steps were taken in English, history, geography, physics, and biology, an appreciable number of students might thus dispose of one or two quarters of college work.

Another simple adaptation to the needs of students superior in ability and preparation has been tried at a number of institutions. One experiment made use of this in both moderate and marked degree. Out of some 600 students enrolled for a course in educational psychology, two "accelerate sections" were made up of students superior in ability, preparation, and motivation. It was felt that, because of their superiority, they needed less instruction, and therefore they met three times a week instead of the usual five. In addition, an "acceleration seminar," comprising very superior students, was formed. Only six intensive evening meetings were held during the entire quarter, plus individual conferences. On an objective final 27 per cent of the regular students made A or B, 53 per cent of those in the accelerate sections, and 94 per cent of those in the accelerate seminar! The less teaching the students received, the better they seemed to do.

After all, might this not be expected? How bungling, stupid, time-wasting, and even perverse many a college class is! No systematic account is taken of students' initial knowledge of the subject; included are some who, at the beginning, already are able to pass the course. Somewhat as a fleet goes only as fast as the slowest ship, so such a class tends to move at the pace of the slower (the low C or D) student. Because of the greater interest in helping the poor student than in facilitating the able, much time is spent on explanations and procedures not needed by the abler students. Often the lecture method is used in medieval fashion to present material by word of mouth, when the same matter is available in better form and could be read by the students in one-fourth the time. Our culture pattern tends to inhibit the able and to motivate for no more than the gentleman's grade. And what a stupid distribution of time—50 minutes a day scattered over five days in the week and continued over a quarter or semester, with much going and coming, picking up the work and then soon dropping it over and over again. When in real life an efficient person begins an undertaking, he surely first takes stock to see where he is and then tries to arrange substantial blocks of time for intensive work in order to complete that undertaking. Why not set up work for our students in such ways, as the "seminar" tried to do? Such methods would seem especially appropriate for returned veterans, eager to complete their full-time education and begin their careers. These methods also save time for the staff and relieve classroom and housing congestion.

Various other means seem feasible. Self-instructional practice exercises have been successful in the services and from elementary school to college. Combinations of two or more related courses, and certain very simple practical experiments with prerequisites have also worked well. The Commission on Implications of Armed Services Educational Programs, appointed by the American Council on Education, will doubtless have valuable suggestions. And if, largely

by the crude methods of the lengthened school year and school day, a fifth of our students can complete a four-year program in three, such technological gains should bring more marked savings of time and effort for both students *and* institutions. The above takes no account of possible curricular pruning and coordination, which might effect further savings.

Résumé and Recapitulation

Wartime acceleration was by no means an isolated war-caused episode, but rather a reappearance of a long-recognized problem. Early and recent studies are in agreement in indicating that younger students tend to be the best students and that the educational lockstep has tended to slow the progress of the ablest students to the rate of the average. Available data agree that early completion of collegiate education tends to be associated with success in adult life. All these conclusions appear supported by basic psychobiological data indicating that American higher and professional education, before the war, had tended to extend beyond the ages of greatest readiness for such learning and to encroach upon the best years for beginning adult socioeconomic life. These problems are now being accentuated by interruptions in education resulting from the war. There is evidence also that wartime acceleration, although for the most part hastily planned and crude in method, was often successful, and scattered but challenging evidence indicates that better methods are available or might readily be devised which would permit more, and better, acceleration. Since the majority of our youth have had their education interrupted, since there is a shortage of individuals with advanced and technical training, and since most universities are swamped with students, the closing question is: What may be done to meet this situation?

The great need is for a reorientation of faculty thinking with regard to this whole problem. Faculties are correct that all-year school endangers their health, restricts their research and scholarship, and makes some students stale and narrow; that mass acceleration, especially in professional schools, asks too much of average and below-average students; and that the heavy schedules of the war period were exhausting for faculty members and many students. The proposals do not involve lengthened school years or heavier course loads for either the faculty or most students. They involve, not mass acceleration, but selective acceleration in proportion to ability, thus facilitating the work of both faculty and students. Faculties are right that standards should not be lowered, and since academic units are ordinarily expressed in terms of time taken (a four-year curriculum or a five-hour course), reduction of years or hours becomes suspect. The unsatisfactory nature of such terms would, however, seem clear: charges of lowered standards against efforts to save time are perverse. Faculties are right that education should not be hurried, but that fact does not justify unnecessary extensions of educational programs into the best years of young adulthood. Faculties are right that gain in intellectual maturity is a major goal of education, but there is evidence that undue extension of educational programs tends rather to prolong adolescence, and that maturity may be furthered by desirable acceleration. Faculties are tragically wrong in the persisting attitude that somehow ingenuity, imagination, and efforts at time and labor saving are inappropriate in higher education, and that during the war or now with the flood of returning veterans all they can do is to lengthen the school year or school day or add staff to do the same old things in the same old way. Continuing practical experimentation to facilitate the work of the faculty and the progress of students should become a regular and expected part of the work of an educational institution. Technological advances *are* possible in education.

We all thrill when advances in medicine add years to life. Such steps as mentioned above could, in effect, add years to the productive adult life of our ablest young people, markedly increase the efficiency of our educational institutions, and aid faculties in the present emergency. If only such steps could be taken now, at this time of greatest need for them, there might be notable advances not only in science and industry but even in education!

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Scanning Science—

With the exception of the advancement of scientific research there is no subject more important to men of science than the adequate teaching of the sciences in our colleges and schools. The efforts now being made by the Natural Science Department of the Educational Association to properly coordinate higher and secondary scientific education should be heartily supported, and those who have read in *Science* the addresses by Profs. Bessey, Carhart, Freer, Jordan, and Gage, at the recent meeting of the N.E.A., will understand what excellent leadership controls the movement.

—4 September 1896

Technical Papers

Effect of Some Sulfhydryl-containing Substances on the Toxicity of an Organic Mercurial Compound[1]

W. K. Long and A. Farah

Department of Pharmacology, Harvard Medical School, and *Thorndike Memorial Laboratory, Second and Fourth Medical Services (Harvard), Boston City Hospital,* and *Department of Medicine, Harvard Medical School, Boston, Massachusetts*

This study was undertaken to test certain substances containing sulfhydryl groups as possible antidotes to the acute toxic action of an organic mercurial diuretic on the dog, cat, and mouse. The trial of such substances for that purpose was suggested by the recent reports on the effectiveness of 2,3-dimercapto-propanol (British anti-lewisite) in poisoning by various heavy metals (*5, 8*), by the reversal of the antibacterial action of inorganic mercury with sulfhydryl compounds (*3, 6*), and by the reactivation of certain sulfhydryl-containing enzymes poisoned with p-chloromercuribenzoate that can result *in vitro* from the addition of compounds containing –SH groups (*1, 7*).

Methods

The organic mercurial diuretic used in these experiments was Salyrgan.[2] The sulfhydryl-containing compounds tested for their antidotal action were cysteine hydrochloride, glutathione, and 2,3-dimercapto-propanol.[3] Cystine and methionine were also tested for possible antidotal action.

The acute intravenous toxicity of Salyrgan alone and of Salyrgan given one minute after the injection of sulfhydryl compounds was determined in mice, and the 50-per cent lethal dose (LD_{50}) was calculated by the method of Behrens (*2*).

Intact cats and dogs were anesthetized intraperitoneally with Dial-Urethane (0.7 cc. per kilogram of body weight). The blood pressure was recorded with a mercury manometer from the carotid artery; the venous pressure, with a water manometer from the right external jugular vein. Electrocardiograms were taken in lead 1 with an ink-writing, "Grass" oscillograph.

Two types of injections of Salyrgan were used: repeated injections of 10 to 25 mg., given into the femoral vein until definite acute toxic manifestations appeared; or constant infusion of Salyrgan into the femoral vein until rhythm irregularities and other toxic manifestations developed, at which point the substance to be tested for antidotal action was injected while the infusion of Salyrgan was continuing. The compounds tested for their antidotal action were injected either into the femoral vein or into the left jugular vein by means of a thin rubber tube which made it possible to inject the material close to the right auricle.

Tests were also made on the dog heart-lung preparation. The technic for this preparation was in general the same as that of Krayer and Mendez (*4*). The anesthetic was 35 mg. of sodium pentobarbital per kilogram of body weight. Arterial, right and left atrial, and pulmonary arterial pressures, cardiac volume, coronary sinus outflow, and systemic output (output of the left ventricle minus coronary flow) were recorded.

Results

The acute intravenous LD_{50} of Salyrgan in the strain of mice used was found to be 103 mg. per kilogram of body weight. Both cysteine hydrochloride and glutathione, given one minute before the administration of Salyrgan, markedly protected the mice against the toxicity of Salyrgan. The LD_{50} was shifted from 103 to 176 mg. of Salyrgan per kilogram by 50 mg. per kilogram of cysteine hydrochloride and to 216 mg. per kilogram by an equimolar amount of glutathione. Cystine and methionine were much less effective than either cysteine hydrochloride or glutathione, but showed a slight degree of protection.

In the intact anesthetized cat and dog, Salyrgan produced manifestations which were mainly referable to the circulation and here, more specifically, to the heart. A lethal dose given either by continuous infusion or by repeated single injections produced a sudden drop of blood pressure, a rise in venous pressure, an increase in heart rate, and electrocardiographic changes characterized by increased PR and QRS intervals, decreased amplitude of T waves, ventricular extrasystoles, and ventricular tachycardia. These effects were all promptly counteracted by cysteine hydrochloride, 5–10 mg. per kilogram; glutathione, 5–10 mg. per kilogram; and 2,3-dimercapto-propanol, 0.5–2 mg. per kilogram. The effect of these substances on ventricular fibrillation induced by Salyrgan is not clearly established, but it is doubtful that such a process, once started, can be counteracted by any of the sulfhydryl compounds.

[1] These experiments were carried out in the laboratory of the Department of Pharmacology, Harvard Medical School. The study was supported by a grant from Winthrop Chemical Company, Inc., New York City.

[2] Kindly furnished by Winthrop Chemical Company, Inc.

[3] Kindly furnished by Dr. E. S. Guzman Barron.

The experiments on the heart-lung preparation of the dog clearly demonstrated the marked antidotal properties of sulfhydryl-containing compounds against the negative inotropic action of Salyrgan. In Table 1 it can be seen that severe heart failure produced by 150 mg. of Salyrgan could be promptly counteracted by 100 mg. of glutathione. Similar effects were

TABLE 1

THE EFFECT OF GLUTATHIONE ON HEART FAILURE PRODUCED BY TOXIC DOSES OF SALYRGAN*

Time in minutes	Systemic output cc./min.	Aortic pressure mm./Hg	Pulmonary pressure mm./H_2O	Right auricular pressure mm./H_2O	Left auricular pressure mm./H_2O	Heart rate per min.
0	400	105	136	19	32	140
5	Salyrgan, 50 mg.					
7	400	105	136	19	32	140
9	Salyrgan, 50 mg.					
11	400	105	136	19	32	140
14	Salyrgan, 50 mg.					
15	370	105	155	25	108	140
16	320	102	250	45	320	
18	100	95	545	94	478	
18.5	50	95	623	100	523	150
19	Glutathione, 100 mg.					
19.5	250	95	409	65	377	156
21	500	110	136	19	32	140
22	400	105	136	19	32	140
24	400	105	136	19	32	140
49	400	105	140	19	35	140

* Heart-lung preparation. Female dog, 10.6 kg. Arterial resistance, 72 mm. of mercury. Blood temperature, 39.0° C. Blood volume, 880 cc. Experiment 2, 14 January 1946.

obtained with 56 mg. of cysteine hydrochloride and 10 mg. of 2,3-dimercapto-propanol. Cystine in doses up to 200–300 mg. did not counteract Salyrgan-induced heart failure. Furthermore, in spontaneous heart failure and heart failure induced by sodium pentobarbital, neither cysteine, glutathione, nor 2,3-dimercapto-propanol had any positive inotropic effect.

SUMMARY

The acute toxicity of an organic mercurial as studied on the mouse, intact anesthetized cat and dog, and the heart-lung preparation of the dog can be readily counteracted by sulfhydryl-containing compounds such as glutathione, cysteine, and 2,3-dimercapto-propanol. Equimolar doses of 2,3-dimercapto-propanol are about five times as active as cysteine or glutathione.

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The Mechanism of Myotonic Contraction

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In 1942, while reviewing the mechanism of myotonias (*5*), the writer concluded that there were several reasons for admitting that the delayed relaxation of myotonic muscle was due to a pathological state of the muscle itself, independent of the central nervous system and of the neuromuscular synapsis.

The most important demonstration of the exclusion of the central nervous system has been furnished by Grund (*3*), Schäffer (*6*), Kennedy and Wolf (*4*), and Denny-Brown and Nevin (*2*), who showed that after nerve or spinal anesthesia, the myotonic reaction still exists in the anesthetized limb. Referring to the synapsis, Brown and Harvey (*1*) pointed out that in myotonic goats the completely curarized muscle shows myotonic phenomena.

The last experiment is crucial, and the only criticism of its generalization is that the experiments were performed on a condition supposed to be similar to that of myotonia in human beings. For these reasons, and counting on the willing cooperation of two patients affected by *Dystrophia myotonica*, experiments were planned to discover the effect of the exclusion of the synaptic mechanism in these patients.

The experiments were performed under penthotal anesthesia. Two shielded electrodes were placed in the median nerve, and two needle electrodes punctured the proximal and distal part of the thenar eminence, respectively. The nerve was stimulated supramaximally by a thyratron stimulator, and the source of the needle electrodes was an a-c potential reductor. The registration was recorded in a smoke drum through a myograph attached to the interphalangic joint of the first finger.

The experiment began with a two-second direct and indirect stimulation of 60 stimuli per second. A suitable dose of *Curare Brasiliensis* injected in the brachial artery, with a cuff to avoid the venous circulation during two minutes after the injection, completely suppressed the effect of the nerve stimulation. The direct stimulation, conversely, reproduced exactly the previous registration, showing that the myotonic delayed relaxation was not influenced by the synaptic exclusion. Also, the percussion of the muscles of the thenar eminence showed the same myotonic responses after full curarization.

In the second patient the effect of variations of frequency of stimulation was studied in addition, but a total curarization was not obtained because of tech-

nical errors. Both patients recovered without disturbances except for a slight paresthesia lasting a fortnight.

The experiments reported fully confirm the research of Brown and Harvey in myotonic goats and localize the origin of myotonic response in the muscle itself.

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Biological Incorporation of a Choline Homologue Into Liver Phospholipids

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Banting and Best Department of Medical Research University of Toronto

Several theories have been proposed to account for the lipotropic action of choline, betaine, methionine, inositol, and other compounds which exert similar effects on the deposition of lipids in the liver. Probably the most attractive hypothesis is one which supposes that incorporation of the active agent into the phospholipid molecule facilitates, in some manner not yet entirely understood, the transport and metabolism of fatty acids.

It is well known that choline and inositol[2] occur naturally in phospholipids. Methionine and betaine apparently exert their effect by donating labile methyl groups for biosynthesis of choline. Ingested choline is incorporated relatively rapidly into liver lecithin (*1*).

The fact that a synthetic analogue of choline, arsenocholine, is lipotropic although it does not possess labile methyl groups, supports the suggestion that the lipotropic action of choline involves reactions which utilize the intact molecule rather than just its labile methyl groups. Welch and Landau (*6*) have shown that dietary arsenocholine is incorporated into the molecule of liver phospholipids, and to them goes the credit for having first stated clearly the arguments in support of the hypothesis outlined above.

More than 10 years ago, however, Channon and Smith (*3*) proposed to test such an hypothesis, viz., that choline exerts its lipotropic action through favoring synthesis of lecithin. Tracer elements being unavailable at that time, a suitable "tracer compound" was sought—an unnatural basic substance with lipotropic properties similar to choline. If such a compound could be found, Channon and Smith suggested trying to discover whether it was incorporated into a new phospholipid molecule in place of the choline of lecithin. They made the triethyl homologue of choline and reported its lipotropic activity. In 1937 Channon, Platt, Loach, and Smith (*2*) attempted unsuccessfully to demonstrate the presence of this base in the phospholipid fraction of the fat extracted from the livers of rats which had ingested about 12 mg. of the compound daily for 20 days. Their statement that they had "established" the absence of the chloroaurate of the ethyl homologue in the least soluble portion of the gold chloride double salt of the choline fraction of the hydrolyzed liver phospholipid, was unfortunate, since it was unjustified in view of the admitted inadequacies of the method used. The inability of Channon, *et al.* to establish, under their experimental conditions, the presence of the ethyl homologue in the liver phospholipid has delayed the general acceptance of the hypothesis that the lipotropic action of choline involves reactions which utilize the intact molecule.

A critical study of their protocols led us to reinvestigate the matter. By feeding larger daily doses of tri-ethyl-β-hydroxyethyl ammonium chloride for a longer period and utilizing new fractionation procedures, we have been able to prove that the ethyl homologue of choline is incorporated into the molecule of a liver phospholipid.

After hydrolysis of the isolated liver phospholipids and removal of the fatty acids, a small portion of the solution was analyzed for choline by the ennea-iodide procedure (*4*) and by the specific microbiological method utilizing the *cholineless* mutant (34486) of *Neurospora crassa* (*5*). A distinct difference in the assay values justified an attempt to prove that the triethyl homologue was present.

The "choline fraction" was precipiated from the hydrolysate with potassium tri-iodide reagent at about 0° C. The bases were freed and oxidized with alkaline permanganate at the boiling point. The resulting tertiary amines were separated by fractional distillation on a microscale and identified as chloroaurates. The finding of trimethylamine (from choline) was anticipated, of course. The isolation of a significant percentage of the fraction as triethylamine, which could have been derived only from the triethyl homologue of choline, proved that this foreign quaternary ammonium base with lipotropic properties had been incorporated into the phospholipids of the liver. Details of this work will be published in the near future.

[1] The writer wishes to acknowledge helpful criticism and suggestions from C. H. Best and C. C. Lucas in the initiation and conduct of this work. The investigation was supported in part by a grant from the Banting Research Foundation.

[2] Although the presence of inositol in liver phospholipids has not yet been reported, a fraction containing inositol has been obtained in this laboratory from a rat liver "cephalin" fraction and is being investigated by L. B. Macpherson and C. C. Lucas.

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The Effect of Alloxan on the *in Vitro* Formation of Glucose by the Liver[1]

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Houssay, Orías, and Sara have recently stated (*3*) that the initial hyperglycemia of alloxan diabetes, which fails to occur in hepatectomized animals, is observed after adrenalectomy or section of the splanchnic nerves, and they expressed the view that the phenomenon must be attributed principally to direct action of alloxan on the liver. Goldner and Gomori (*2*) and Kirschbaum, Wells, and Mollander (*4*) were unable to demonstrate an initial hyperglycemia in dogs and rats, respectively, after adrenalectomy.

The experiments here reported may throw some light on the direct effect of alloxan on the liver. Respiring rat liver slices were suspended in 3 cc. of a glucose-free modified phosphate-buffered Ringer's solution (MPBR) to which, in certain of the flasks, alloxan was added in 0.0014 M concentration, which is roughly equivalent to the concentration that would occur if there is an equal distribution throughout the body after a subcutaneous injection of 200 mg./kilo. The amount of glucose (as total reducing substances by the ferricyanide method of Folin) appearing in the medium after one hour's shaking in oxygen at 37° C. was measured, with the results given in the table.

Each figure represents the average of three observations. Control and alloxan-treated tissues of each experiment were taken from the pooled liver slices of the same animal. The glucose appearing in the medium was the same, within the limits of error, in the alloxan-treated tissues as in the controls. Assuming that the dry weight of rat liver is 28 to 30 per cent of the wet weight, it can be calculated that the glucose in the medium represented about 6 per cent by weight of carbohydrate in the liver slices. Only glycogen could have been the source of most of this material.

In four animals made diabetic by a subcutaneous injection of 200 mg. alloxan/kilo, 48 hours previously, the amount of glucose appearing in the medium is less than one-fifth of the amount seen in the case of the normal liver. Lackey, Bunde, Gill, and Harris (*5*) have shown that in alloxanized rats with moderate to severe diabetes the liver glycogen is low, and we attribute the lessened formation of glucose in the diabetic livers to this fact.

Exp. No.	Blood sugar in mg. %	Liver slices in MPBR: Dry wt. of tissue (mg.)	Liver slices in MPBR: Glucose in medium (mg.)	Liver slices in MPBR: Glucose/mg. dry wt. of tissue (μg.)	Liver slices in MPBR plus alloxan: Dry wt. of tissue (mg.)	Liver slices in MPBR plus alloxan: Glucose in medium (mg.)	Liver slices in MPBR plus alloxan: Glucose/mg. dry wt. of tissue (μg.)
Normal Rats							
1		15.0	4.35	290	16.2	4.20	259
2		17.2	2.55	148	14.0	2.86	204
3		12.9	2.55	197	13.6	2.62	193
4		14.9	2.70	181	15.5	2.92	188
5		16.6	2.85	172	16.1	2.52	156
6		11.6	2.32	200	11.7	2.85	243
		Average		198 ± 20	Average		207 ± 15
Diabetic (Alloxan) Rats							
7	520	13.8	0.345	25	12.9	0.368	28
8	520	13.0	0.555	43	11.8	0.435	37
9	760	16.1	0.270	17	15.7	0.330	21
10	450	12.5	0.600	48	13.2	0.720	55
		Average		33 ± 7	Average		37 ± 8

Our results indicate that alloxan has no direct effect on liver glycogenolysis and are therefore opposed to the concept of Houssay, *et al.* in regard to the origin of the initial hyperglycemia of alloxan diabetes. The possibility remains that alloxan may act upon the liver via nervous pathways, as suggested by the recent observations of Braulio (*1*) in the cat.

[1] Aided by grants from the Committee on Research in Endocrinology of the National Research Council and the Charlton Fund.

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News and Notes

About People

Dinsmore Alter has returned to his duties as director of the Griffith Observatory, Los Angeles, after more than four years of service in the Transportation Corps of the Army.

Marshall H. Stone, Harvard University, has been appointed Andrew MacLeish distinguished service professor of mathematics and chairman of the Department at the University of Chicago, beginning with the fall term.

T. D. Luckey, Department of Biochemistry, University of Wisconsin, has joined the staff of the Laboratories of Bacteriology, University of Notre Dame, as biochemist.

Mary Landon Sague, chairman of the Department of Chemistry, Vassar College, was awarded the degree of Doctor of Science by Middlebury College on 17 June.

S. S. Cairns, Queens College, Flushing, New York, has been appointed professor of mathematics and chairman of the Department of Mathematics at Syracuse University.

Raymond T. Ellickson, assistant professor of physics, Polytechnic Institute of Brooklyn, has been appointed associate professor of physics, Reed College, Portland, Oregon.

L. E. Cunningham has been appointed assistant professor of astronomy in the Berkeley Astronomical Department, University of California. The appointment became effective on 1 July.

Graham L. Moses, L. R. Hill, and *James DeKiep,* Westinghouse East Pittsburgh Division, received the American Institute of Electrical Engineers' award and $100 prize for the best paper on engineering practice, at the summer meeting of the AIEE in Detroit, Michigan. Their paper dealt with the application of silicones, the outstanding new materials made from sand, oil, coal, and brine, that are setting aside thermal limitations in the insulation field.

M. D. Farrar, secretary-treasurer of the Central States Branch, American Association of Economic Entomologists, left the Midwest on 1 July to become associate director of the Crop Protection Institute, Durham, New Hampshire. J. W. Apple will take over Dr. Farrar's duties as secretary-treasurer.

K. S. Quisenberry, who has been stationed at the College of Agriculture, Lincoln, Nebraska, since 1936, has been made head of the Office of Cereal Crops and Diseases, Department of Agriculture, Washington, D. C. He replaces M. A. McCall, who will devote full time to his position as assistant chief, Bureau of Plant Industry, Soils, and Agricultural Engineering.

Richard C. Webster has been appointed an instructor in the Department of Anatomy, University of Kansas Medical School, Lawrence.

Laurence L. Sloss, formerly associate professor of geology, Montana School of Mines, has been appointed lecturer in paleontology at Northwestern University. During the late summer and fall, he will do consulting work in petroleum geology in eastern Montana and Wyoming and will be in residence at Northwestern for the winter and spring quarters.

Capt. A. Chapanis has been appointed instructor in psychology and research associate in the Systems Research Project, The Johns Hopkins University. Prior to his release from active duty, Capt. Chapanis had been assigned to the Aero Medical Laboratory, Air Materiel Command, Wright Field, Dayton, Ohio, as aviation psychologist.

H. L. Ansbacher has been appointed associate professor in the Department of Psychology, University of Vermont.

Leonard S. Wilson, formerly of OSS, has been appointed professor of geography, Carleton College, Northfield, Minnesota.

H. Bruce Collier, formerly associate professor of biochemistry, Dalhousie University, Halifax, Nova Scotia, has been made professor of biochemistry, University of Saskatchewan, Saskatoon.

William King Gregory was guest of honor at a banquet on his 70th birthday, 19 May, in New York City. Prof. Gregory was presented with a bound volume of letters from friends and former students and a large portrait of himself, painted for the occasion. The portrait was given by him to Columbia University and is to be hung in the Columbia Classroom, American Museum of Natural History. Dr. Gregory told of his 50 years association, as student and teacher, with the Department of Zoology, Columbia University. The final speaker, James H. McGregor, spoke entertainingly on Prof. Gregory's career and some of the factors influencing it.

Announcements

A very significant change in Selective Service regulations dealing with scientific faculty personnel is embodied in the new Local Board Memorandum 115, issued by Selective Service and dated 12 August. According to this new memorandum, faculty personnel generally is deferrable and will be certified by the U. S. Office of Education upon request by the employing institution on Selective Service Form 42A (Special Revised). In the sciences and engineering, registrants can be certified by the Office of Research and Development if they are graduate students accepted for an advanced degree or are engaged in university or industrial research. Further details may be secured from any Selective Service Local Board by asking for LBM 115 or by writing to the Office of Scientific Personnel, National Research Council, Washington, D. C., for a recent bulletin giving details.

An Office of Technical Services, headed by John C. Green, has been established recently, according to an announcement by the Department of Commerce. The new Office consolidates the work of the Office of the Publication Board, Technical Industrial Intelligence Branch, National Inventors Council, and Production Research and Development Division. According to Mr. Green, who has served as executive secretary of the Publication Board and chief engineer of the National Inventors Council, the Office will continue the work of the consolidated units and launch a new program of technical aid to business and industry. The 1946–47 appropriation, just approved by Congress, includes increased administrative funds for the new Office, as well as $1,500,000 for research and development.

OTS will consist of four major units: Invention and Engineering Division, Industrial Research and Development Division, Library and Reports Division, and Technical Industrial Intelligence Division. The latter is responsible for investigation of German industry and the collection of German scientific and technical information.

A Service on Feed Composition, parallel to that on Food Composition under the Food and Nutrition Board, is being set up by the Agricultural Board of the National Research Council. Both services are administered through the Division of Biology and Agriculture. The new Service is financed in part by a grant of $18,000 from Swift & Company. It is under the charge of a committee composed of: R. V. Boucher, chairman; F. E. James, executive secretary; K. C. Beeson, L. E. Bopst, C. F. Huffman, J. E. Hunter, H. L. Lucas, F. B. Morrison, E. M. Nelson, and B. H. Schneider.

The Edison Laboratory, central research organization of Thomas A. Edison, Inc., West Orange, New Jersey, announces the formation of a new laboratory section for fundamental research in the branches of science which are the bases of the company's business in dictating machines, batteries, electrical instruments, and other electrical devices. The technical staff of the new group includes: Robert S. Weisz, Richard W. Iskraut, S. S. Jaffe, and Robert L. Tichenor.

The National Society for Medical Research, a clearing house for information on medical studies and discoveries, has been organized under the sponsorship of the Association of American Medical Colleges with the cooperation of 101 scientific organizations. National offices are at 25 East Washington Street, Chicago 2, Illinois. The Society has as its purpose the advancement of research in medicine, biology, pharmacy, dentistry, and veterinary medicine. Anton J. Carlson, president of the Society, has emphasized that an important function of the Society is to analyze and expose the propaganda of small but highly vocal groups which object to the use of animals in the experiments without which medical science would still be in its infancy.

Ralph A. Rohweder, 1946 president of the Chicago Junior Association of Commerce and former consultant and editor for the National Safety Council, has been appointed executive secretary, and A. C. Ivy, head of the Department of Physiology, Northwestern University, secretary-treasurer. On the Board of Directors are: R. B. Allen, University of Illinois; Alfred Blalock, The Johns Hopkins University; C. S. Burwell, Harvard University; E. J. Carey, Marquette University; L. R. Chandler, Stanford University; W. C. Davison, Duke University; R. E. Dyer, National Institute of Health; H. S. Gasser, Rockefeller Institute; E. W. Goodpasture, Vanderbilt University; J. G. Hardenbergh, American Veterinary Medical Association; J. C. Hinsey, Cornell University; Victor Johnson, American Medical Association; C. D. Leake, University of Texas; E. M. MacEwen, University of Iowa; W. S. McEllroy, University of Pittsburgh; B. O. Raulston, University of Southern California; A. M. Schwitalla, St. Louis University; Isaac Starr, University of Pennsylvania; E. L. Turner, University of Washington; and Floyd S. Winslow, Medical Society, State of New York.

The Department of Physiology and Pharmacology, Chicago Medical School, has received a second $2,000 grant from the John and Mary R. Markle Foundation to support the investigation of Piero P. Foa and

Jay A. Smith on the metabolism of thiamine in the diabetic animal. The Department is also the recipient of a $3,000 grant from the Upjohn Company, Kalamazoo, for the establishment of an Upjohn fellowship in physiology, under Dr. Foa. Dr. Foa has just returned from a lecture tour in Brazil.

Maj. Merrill Moore, formerly of Harvard University and at present surgeon for the Military Advisory Group in China, has drafted a health sanitation program to halt cholera and typhus in the Nanking camps and prevent their spread to Shanghai and through the Orient. Maj. Herbert K. B. Jemmott, of Phoebus, Virginia, working with Maj. Moore, devised a special spraying system, mounted the equipment on an Army C-47, and thoroughly dusted the repatriation staging areas with a mixture of DDT and water from an altitude of 75 to 100 feet. Since the Chinese obtain drinking water from open pools, the Army is unable to use the normal spraying mixture of kerosene and DDT which, being heavier, gives greater insect-killing effect.

Elections

The International Association for Dental Research elected the following officers at a recent meeting in Kansas City: Samuel W. Chase, president; Harold C. Hodge, president-elect; and Alan G. Brodie, vice-president.

Robert R. McMath, director of the McMath-Hulbert Observatory, University of Michigan, has been elected chairman of the Board of Trustees of Cranbrook Institute of Science, Bloomfield, Michigan.

Donald G. Marquis is president-elect of the American Psychological Association for 1947, according to an announcement made to the membership during the annual meeting at Philadelphia on 6 September.

Bennett T. Simms, chief of the U. S. Bureau of Animal Industry, was installed on 22 August as president of the American Veterinary Medical Association at the closing session of its 83rd annual meeting at Boston. Dr. Simms was elected at the Association's last meeting at Chicago in 1944, but since no meeting was held in 1945, he could not be installed until this year.

The Scarcity of Scientific Man Power in Great Britain

A report on scientific man power of interest to readers in the United States was published on 27 May 1946 by a committee appointed by the Rt. Hon. Herbert Morrison, M.P., Lord President of the Council. This committee was headed by Sir Alan Barlow, and its members included Sir Edward V. Appleton, Prof. P. M. S. Blackett, Mr. Geoffrey Crowther, Sir Alfred Egerton, Sir George Nelson, and Prof. S. Zuckerman.

The committee considered the immediate problem of reconversion as well as the long-range problem of matching supply and demand for scientific personnel. With regard to the immediate problem, the committee merely recommended certain additional procedures for expediting the return of scientific and technical personnel to their former activities and emergency accommodations at the universities, particularly those having suffered war damage.

With regard to the long-time problem, the committee attempted to estimate the scientific position in 1950 and 1955. They presented the following conclusions:

	1950	1955
Minimum requirement of qualified scientists	70,000	90,000
Maximum number likely to be available if expansion in the output of graduates is limited to that envisaged in the returns to University Grants Committee	60,000	64,000
Deficit	10,000	26,000

It is essential, therefore, that the output of scientific graduates should be increased very much above the level of expansion at present envisaged by the universities; the immediate aim should be to double the present output, giving approximately 5,000 new scientists every year at the earliest possible moment.

The report calls attention to the fact that there is in England a reservoir of innate intelligence that has not been tapped and that by additional financial assistance on a larger scale, much of this talent could be saved for the universities. It calls attention to the fact that even if the total student population in British universities were doubled, the country would still lag behind European countries and the United States in the relative provision made for higher education. They recommend the establishment of a number of technical colleges giving full-time technological courses of university degree standard, and that the universities accept the responsibility for training an additional number of first-class technologists.

It is interesting that this report dealing with the sciences emphasizes that substantial expansion in the number of students studying the humanities should occur, *i.e.* the humanities should not be sacrificed to the need for an increased output of scientists and technologists. It calls attention to a problem which will strike a responsive chord in American ears, namely that of finding additional teachers, improving teacher efficiency, and giving individual teachers adequate time for their own research. The committee emphasizes

that additional student population should be met with a proportionate expansion in the number of teachers if the quality of the work and the standing of the university are not to suffer.

The committee recommends that in the allocation of the limited supply of scientists during the reconversion period the order of preference should be: (1) teaching and fundamental research; (2) civil science, both government and industrial; and (3) defense science.

Attention is called to the importance of maintaining an adequate nucleus of able scientists working on the problems of defense, but the committee feels that the most important immediate task is to reconstruct the central core of fundamental research and teaching. As one means of implementing the order of priority improvement of the attractions of an academic career is called for.

The report represents the deliberations of the committee since its appointment in December 1945. A copy may be secured from His Majesty's Stationery Office. A review of the article appeared in *Nature* for Saturday, 15 June.—*M. H. Trytten* (Director, Office of Scientific Personnel, National Research Council).

In the Laboratory

Agar Technique for Arresting Movement in Protozoa

W. S. Bullough
Department of Zoology, McGill University

Of the several well-known methods of hindering the movements of active Mastigophora and Infusoria so that they can be examined easily through a high-power microscope, none appears to be entirely adequate, and a new technique based on the use of agar has been developed. The idea came from the papers of Whitaker and Berg (*2*), who used agar solutions when studying the development of Fucus eggs, and of Holtfreter (*1*), who adopted the same method when working on the growth of amphibian embryos.

The modification developed for the Protozoa is as follows: Place a *small* drop of the culture solution on a glass slide. Avoid including sand grains or other large pieces of detritus, as these will hold up the cover glass and prevent the use of high-power objectives. Place an equal-sized drop of a melted solution of agar on a cover glass (a 1-per cent aqueous solution kept liquid at about 40° C. in a water bath or oven), immediately invert the cover glass, center the drop of agar solution directly over the drop of culture solution and let the cover glass fall. As the two drops merge and the agar rapidly cools, the mixture becomes solid. The jelly formed in this way contains large numbers of tiny water spaces, most of which are smaller than the field of a high-power microscope, and in these the protozoans are confined. Large species are often held so tightly that they are unable to turn around, but smaller ones can swim about in small circles. If required, animals can be held more tightly by increasing the size of the agar drop relative to the drop of culture solution or by using a 1.5-per cent solution of agar.

The animals continue living in these conditions for at least half an hour and often for many hours (the actual time apparently depending both on size and on species). The cover glass is held sufficiently firmly for an oil-immersion objective to be used. However, care must be taken not to press upon or otherwise move the cover glass, since this will break the jelly reticulum and release the animals.

In the case of marine Protozoa, the agar solution must be made up in sea water, and in the case of parasitic Protozoa, such as those found in the rectum of the frog, it must be made up in normal saline.

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A Simple and Accurate Soil Fumigant Injection Apparatus[1]

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The accurate application of liquid soil fumigants for experimental purposes is somewhat difficult when

[1] Published with the approval of the director as Miscellaneous Paper No. 42 of the Pineapple Research Institute, University of Hawaii.

the ordinary commercial applicators are used. The latter fail to deliver uniformly measured doses, since the solvent properties of many materials may destroy rubber, leather, or plastic gaskets in these applicators. In the course of studies with fumigants in pineapple fields under circumstances where depth of application as well as unit dosages were factors, it became

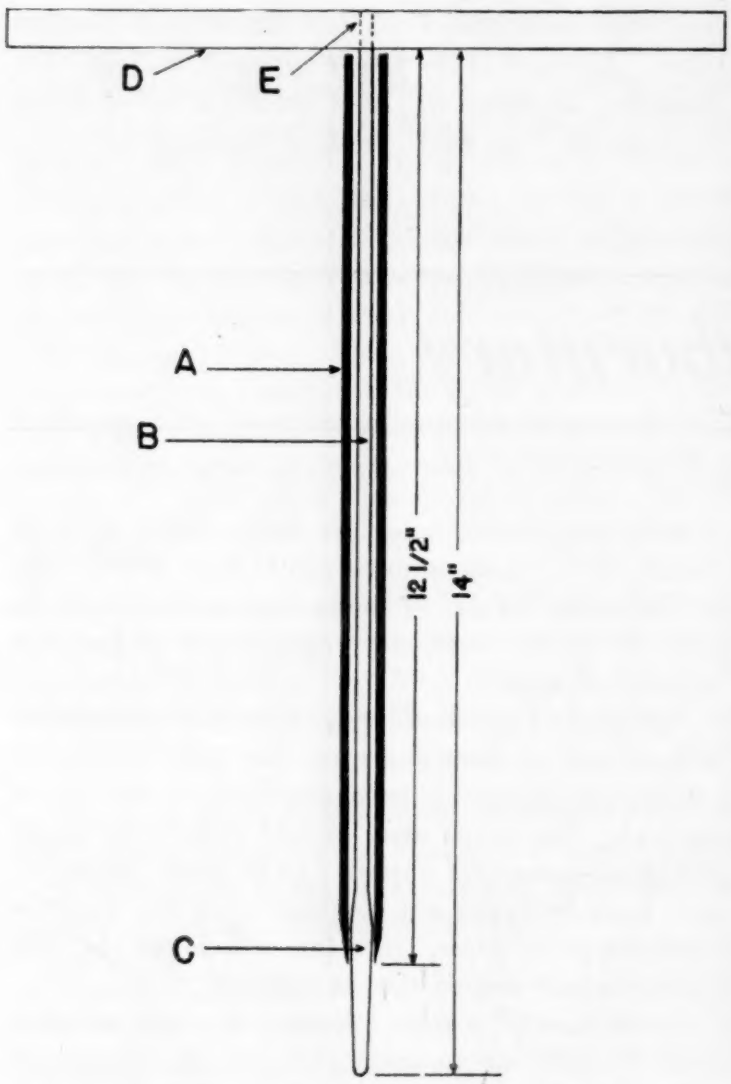

FIG. 1. Assembled injection apparatus. A—standard ¼-inch pipe; B—¼-inch steel rod; C—enlargement tapering toward point; D—pipe handle; E—weld.

necessary to apply a great variety of materials with considerable precision. The applicator described below has been eminently satisfactory and, being of cheap and simple construction, is worthy of description for the use of other workers in the field.

The device consists of a length of iron pipe of approximately ¼-inch inside diameter, sharpened at one end, and an iron prod with a transverse handle, as shown in Fig. 1. It was found that the device operated with greater ease if the prod was slightly enlarged at the end and tapered toward the tip. The assembled pipe and prod are thrust into the soil to the required depth, the prod withdrawn, and the fumigant poured into the pipe and allowed to drain, after which the pipe is withdrawn from the soil and the hole closed. In practice it was found desirable to have enough pipes to treat an entire plot without resetting pipes. With pineapple the current standard plot requires 100-unit doses, but this would vary with other crops, depending on the plot size required for calculating significance of results.

A number of measuring devices ranging from simple, graduated cylinders to serological syringes have been used to measure the unit dose of liquid. The most satisfactory method has been the use of glass burettes of 100-ml. capacity, the unit doses being marked with steel or brass bands on the outside of the burette.

This device might also be used by the home gardener or for treating seed beds in glasshouses, where the number of unit doses is sufficiently small not to merit investment in more complicated and expensive equipment.

A Spectrophotometric Method for the Determination of p,p′-DDT

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In 10 minutes 10–50 μg. of p,p′-DDT may be determined with an error not greater than 10 per cent. A large number of analyses may be run at one time.

PRINCIPLE

When dissolved in 95 per cent ethanol p,p′-DDT absorbs very slightly at 250 mμ. After dehydrochlorina-

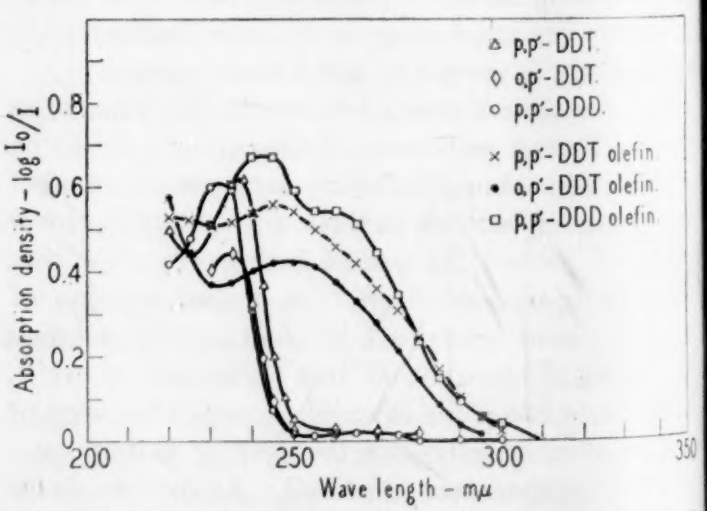

FIG. 1. Ultraviolet absorption curves of 10 μg./ml. of p,p′-DDT, o,p′-DDT, p,p′-DDD, and their respective olefins dissolved in 95 per cent alcohol.

tion by dilute alcoholic NaOH to the olefin, 2,2,-bis(p-chlorophenyl)1,1-dichlorethylene, the solution absorbs strongly at this wave length (see Fig. 1). Measure-

ent of this increase in absorption and comparison ith that obtained with a similarly treated standard DT solution is the basis of the present method. The rincipal impurity in commercial products (*4*), o,p′-DT, changes only slightly to its olefin by the pres-nt method and is therefore not determined.

Procedure

(A) Three ml. of solution of DDT in 95 per cent lcohol containing 2–20 μg. DDT/ml. is pipetted into 30- to 50-ml. test tube and placed in a 37° C. water ath. Five-tenths ml. of 0.7 N alcoholic NaOH (or OH) is added, and after five minutes the alkali is eutralized with 0.1 ml. (3 drops) of 4 M acetic acid.

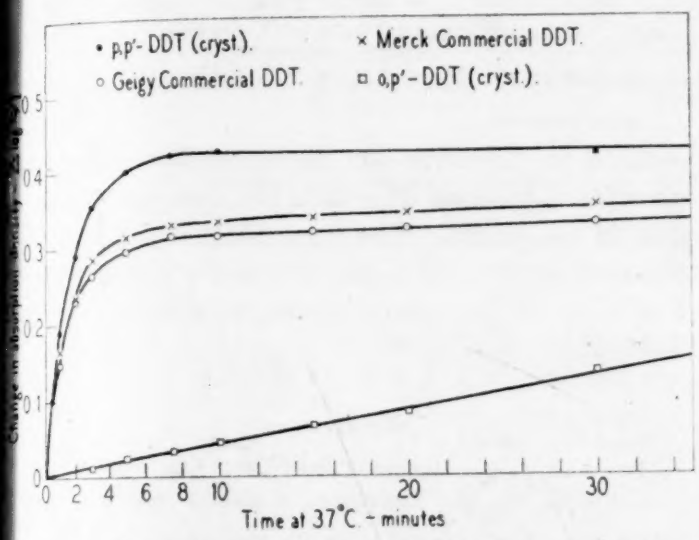

Fig. 2. Change in absorption value at 250 mμ with time of dehydrochlorination in 0.1 M NaOH in 95 per cent alcohol at 37° C. of crystalline pure p,p′-DDT, o,p′-DDT, and two commercial preparations.

(B) In this sample, which is a control or blank, the quantities of alkali and acid indicated in A are mixed before addition of the 3-ml. aliquot of DDT solution.

(C) This sample is merely the solvent control. To 3 ml. of 95 per cent alcohol is added 0.5 ml. of 0.7 N NaOH (alcoholic) and 0.1 ml. of 4 M acetic acid.

Spectrophotometric Measurement[1]

Samples C, B, and A, in this order, are placed in a Beckman D U photoelectric spectrophotometer and the absorption measured at 250 mμ. C, the solvent, is used in balancing the spectrophotometer. The difference between the absorption of B and A is due to the olefin formed by dehydrochlorination of the p,p′-DDT by alcoholic NaOH. The weight of p,p′-DDT corresponding to the difference in absorption is read directly from a standard curve.

Results

Table 1 contains the analyses of different dilutions of several different preparations of DDT. The starting solutions were all 2 per cent by weight of DDT dissolved in commercial kerosene. The change in absorption increases linearly with the concentration of material in accordance with Beer's law. The lower values in Table 1 and Fig. 2 for the commercial preparations are in agreement with the findings of Haller, Bartlett, Drake, *et al.* (*4*) that commercial preparations contain about 70 per cent p,p′-DDT. These results also show that the change in absorption is directly proportional to the concentration of p,p′-DDT.

Specificity of the Method and Interfering Substances

The work of Busvine (*1*) and of Cristol (*3*) led to the present method, which is relatively specific for p,p′-DDT. These workers showed that o,p′-DDT and p,p′-DDD (the dichlorethane analogue of DDT) dehydrochlorinate at much lower rates than does p,p′-DDT. The quantity of p,p′-DDD in commercial preparations is apparently small, whereas the o,p′-DDT is 15–20 per cent (*4*).

Results of experiments to determine the time at which the largest proportion of p,p′-DDT was dehydrochlorinated with a minimum of change in the o,p′ isomer are shown graphically in Fig. 2. After five minutes at 37° C. in 0.1 N alcoholic NaOH, pure p,p′-DDT is 95 per cent converted to its olefin, whereas o,p′-DDT was changed only 5–10 per cent. Busvine (*1*) also found that the o,p′-DDT was much lower in its biological action than p,p′-DDT.

Other materials analyzed to determine their possible interference were: bis(p-chlorophenyl) acetic acid, bis(p-chlorophenyl) sulfone, and 2-trichlor-l-o-chlorophenylethyl-p-chlorobenzene sulfonate. No interference was encountered other than a rise in the blank value in some instances.

Many substances, crude kerosene in particular, absorb strongly in the region of 250 mμ, causing high blank values. However, in the sprays as ordinarily employed (2–5 per cent DDT in commercial kerosene) the absorption by kerosene has not been high enough to reduce the precision of the measurement (see Table 1). If the proportion of kerosene is increased so that the blank or B absorption value is high compared to that derived from the DDT olefin, then the error in estimating the DDT will increase. Dilutions were always made in the nonabsorbing solvent, 95 per cent ethanol.

Effect of Certain Variables on Absorption Value

(1) The effect of the concentration of DDT on the absorption value is linear.

(2) The wave length setting is important, particularly if a standard solution is not analyzed simul-

[1] Neal, *et al.* (*5*) described a spectrophotometric method for determining DDT, but it was applicable only to solutions free from any other material absorbing in the region of 237 mμ.

taneously, for, as may be seen from Fig. 1, the absorption curve of the DDT sample rises abruptly below 250 mμ.

(3) The time of heating should be within 0.25 minutes of 5.

Apparatus

The Beckman quartz ultraviolet photoelectric spectrophotometer (*2*) has been used throughout this work. The wave length scale was standardized, as recommended, with the hydrogen 656-mμ line. It was

TABLE 1

Spectrophotometric Analysis of Different DDT Preparations

DDT/ml. in μg.	Absorption Density—Log I_0/I											
	3 × Crystallized p,p′-DDT			Merck Commercial			Geigy Commercial			Artificial Mixture 75% p,p′-DDT and 25% o,p′-DDT*		
	A	B	Δ	A	B	Δ	A	B	Δ	A	B	Δ
2	.14	.082	.06	.12	.08	.04	.115	.06	.055	.1	.06	.04
5	.32	.155	.165	.275	.165	.11	.275	.155	.12	.285	.145	.14
10	.63	.31	.32	.565	.295	.27	.56	.31	.25	.55	.32	.23
20	1.23	.62	.61	1.07	.58	.49	1.12	.60	.52	1.08	.6	.48

* This and most of the other related pure chemicals were kindly placed at our disposal by S. J. Cristol and H. L. Haller of the Agricultural Research Administration, Beltsville, Maryland.

(4) The reaction is bimolecular, and the rate is proportional to the hydroxyl ion concentration.

(5) The temperature of the reaction should be controlled to a few tenths of a degree. The results of the work of Cristol (*3*) indicate a temperature coefficient of about 3 for 10° C.

(6) The time of standing after neutralization of the alkali causes no appreciable change up to several hours.

Extinction

The extinction, $E^{1\%}_{1\text{ cm.}}$, for pure p,p′-DDT olefin at 250 mμ, close to a peak of absorption, is about 550, and the molecular extinction, ε, is about 18,000. The peak of absorption for pure p,p′-DDT is at 237 mμ, the extinction in this case being 550, and ε, 20,000.

checked in the ultraviolet region by determining the absorption maxima of a 0.02-per cent benzene solution in iso-octane. The three highest maxima were observed at 261, 245.5, and 249 mμ, which are within 1 or 2 mμ of the values in the International Critical Tables.

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Letters to the Editor

The Ascorbic Acid Content of Some Malpighia Fruits and Jellies

In a recent issue (*Science*, 1946, **103**, 219) Asenjo and Freire de Guzmán reported the exceptionally high ascorbic acid content of the West Indian cherry (*Malpighia punicifolia* L.). These workers found that the fruits, when fully ripe, contain an average of 1,707 mg. of ascorbic acid per 100 grams of edible material and, when unripe, 2,963 mg.

Apparently some confusion exists as to the identity of the species of Malpighia grown in southern Florida and commonly referred to as the Barbados cherry. Mowry and his associates (*Fla. agric. Exp. Sta. Bull.*, 1941, **109**, 65–67) have applied this common name to *M. glabra*, whereas Sturrock, in his *Tropical fruits for southern Florida and Cuba and their uses* (1940), has applied it to *M. punicifolia*.

In the present investigation, fruits and herbarium material were collected from four plants, three of which were thought by their growers to be *M. glabra* and one, *M. punicifolia*. The latter bush is located at the U. S. Plant Introduction Garden, a few miles south of Miami, Florida. All of these herbarium specimens were identified by H. A. Gleason and his associates, of the New York Botanical Garden, as *M. punicifolia*. Fruits were also collected from a plant of *M. coccigera* and from an un-

entified species of Malpighia bearing small, red fruit. ive jars of homemade "Barbados cherry" jelly were so obtained for analysis. The identity of the species Malpighia used in the preparation of this jelly is unown to the author. A small amount of lime juice was ed in place of commercial pectin in the preparation of e jelly.

The colorimetric method described by Loeffler and onting (*Ind. eng. Chem.* (Anal. ed.), 1942, 14, 846–849) s followed in making these ascorbic acid determinaons except that a calibration curve was used instead of e formula recommended by these workers for convertg the colorimeter readings into milligrams of ascorbic id per 100 grams of fruit. The results of the analysis re given below:

TABLE 1

DATA ON THE ASCORBIC ACID CONTENT OF SOME MALPIGHIA FRUITS AND JELLIES

Material	Description of sample	No. of analyses	Ascorbic acid content (mg./100 grams edible fruit)	
			Average	Range
punicifolia L.				
	Tree A			
	Slightly over-ripe	4	1,219	1,028–1,378
	Firm ripe	8	1,579	1,268–1,778
	Almost ripe	4	2,103	2,019–2,172
	Beginning to ripen	8	3,250	2,710–3,774
	Unripe	4	4,468	4,090–4,676
	Trees B_1 and B_2			
	Firm ripe	2	2,712	2,712–2,712
	Unripe	2	4,462	4,400–4,524
	Tree C			
	Firm ripe	4	1,699	1,564–1,782
coccigera L.				
	Ripe	4	69	64– 74
lpighia sp.				
	Ripe	4	17	14– 21
rbados cherry jelly				
	Individual jars			
	#1	3	683	674– 688
	#2	3	499	499– 500
	#3	3	763	725– 807
	#4	3	541	538– 546
	#5	2	509	492– 525

It is apparent from these data that the *M. punicifolia* own in southern Florida is also an excellent source of corbic acid. These unripe fruit were found to contain nsiderably more ascorbic acid than those grown in uerto Rico. The other two species of Malpighia were und to contain a comparatively small amount of corbic acid. The high ascorbic acid content of the lly, highly acclaimed for its flavor and color, is parcularly noteworthy, since much of the fruit of the soalled Barbados cherry is utilized in its preparation. An erage serving of approximately three level teaspoonfuls this jelly will more than supply the daily requirement 100 mg. of ascorbic acid.

This investigation was sponsored by the Science Research Council of the University of Miami.

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Notes on the Results of Army Intelligence Testing in World War I

Publications during the past two years have indicated a renewed interest in the Army tests of World War I with regard to their significance for the problem of Negro-white differences in intelligence. While most studies have been primarily concerned with the Alpha examination, M. F. A. Montagu's work (*Amer. J. Psychol.*, 1945, 58, 161–188) suggests that a more extensive consideration of the Beta results may be worth while.

The Beta is a performance test designed for use with illiterate and foreign groups in the population. Although it is widely recognized that socioeconomic opportunities play an important role in determining Alpha scores, it is not generally clear that Beta scores are similarly influenced. For this reason it may be incorrectly assumed that, while Negro-white differences in Alpha level cannot be taken at face value, Beta differences (which Montagu found to be in the same direction) indicate innate 'racial' inequality. It is our purpose here to show, however, that the Beta levels for the various states are significantly related not only to Alpha levels for the same states but also to yearly educational expenditures and per capita incomes. These correlations are presented in Table 1.

TABLE 1

RANK-ORDER CORRELATIONS BETWEEN MEDIAN BETA SCORES FOR THE VARIOUS STATES* AND MEDIAN ALPHA SCORES,* ANNUAL EDUCATIONAL EXPENDITURES (1910), AND PER CAPITA INCOMES (1919)

(All coefficients significant at 1 per cent level)

	Educational expenditures per capita population, 5–17 yrs.†	Per capita income‡	Alpha (white)	Alpha (Negro)
Beta (white)	.64 (.81)§	.50 (.64)§	.67	..
Beta (Negro)	.72 (.76)§	.67 (.72)§	..	.65

* Data from Montagu. N ranges from 47 to 49 in the case of the correlations for whites and from 23 to 24 in the case of those for Negroes.

† Expenditures for public elementary and secondary schools (1910). Data from *Statistical Abstracts of the United States*, 1930, No. 52, U. S. Dept. of Commerce.

‡ Data from W. C. Bagley's *Determinism in education*. Baltimore, Md.: Warwick and York, 1925.

§ Figures in parentheses are comparable correlations with median Alpha scores.

Why should there be a significant relationship between the intelligence of literate and illiterate samples from the populations of the various states? The hereditarian might, of course, argue that the Alpha-Beta correlation for whites merely reflects the presence in the industrialized northern states of intelligent but non-English-speaking immigrants, although in other contexts the relatively low intelligence scores of these immigrant groups cause them to be referred to as the 'dregs' of Europe. However, hereditarians can only explain away the Alpha-Beta correlation for Negroes by postulating selective migration, an hypothesis which Klineberg's work (*Race differences*. New York: Harper, 1935) has largely invalidated. It is probably most warranted to conclude from the correlations presented here that Beta scores, like Alpha scores, are strongly influenced by cultural factors concomitant with the socioeconomic levels of the states; verbal and numerical facility are not the only evidences of environmental forces. From this point of view group differ-

ences in intelligence, whether measured by Alpha or Beta, are to be interpreted in similar terms.

In an early survey of the results of Army intelligence testing during World War I, W. C. Bagley (*Determinism in education*. Baltimore, Md.: Warwick and York, 1925) emphasized the large difference between the levels of northern and southern states. "This difference is not a gap," he remarked, "it is a chasm" (p. 69). What will the results for World War II show? The relationship between test scores and educational expenditures described above affords a basis for prediction.

The rank-order correlation between state expenditures for education in the years 1910 and 1932 is .85. The ratio of expenditures by the 10 highest states to those of the 10 lowest states in 1910 is 5.5:1, while the ratio for 1932 is 4.2:1. The same 10 southern states comprised the lowest group both in 1910 and 1932. In neither year was a southern state included in the highest group. From these data it seems reasonable to predict that the results for World War II will show north-south differences which, if not on the order of a 'chasm,' will nevertheless represent a wide gap. The validation of this prediction would imply the failure of social plans based on the doctrine of states' rights and the need for a stronger federal emphasis in meeting the problems implicit in the data under discussion. (It should be recognized, of course, that differences in educational expenditures are paralleled by a variety of other socioeconomic differences; educational expenditures merely provide a convenient index of the totality of other factors.) A national rather than a state-wide perspective would be indicated to ensure the democratic development of the human resources of the United States.

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Embryonic Induction in Regenerating Mesenchyme

A series of reports have been made by the undersigned on the development of various regions of the early embryo differentiating in the midst of regenerating tissue of *R. pipiens larvae* (*J. exp. Zool.*, 1940, 83, 191; 1941, 87, 403; 1942, 90, 353; 1943, 93, 185; 1944, 95, 61; 1944, 97, 1). The development of some of the same early embryonic areas in salt solution has also been studied (*J. exp. Zool.*, 1945, 100). The work has shed light on the embryonic induction of several different organs, including epidermis, nose, horny jaws, and suckers. For these and other organs the series of studies have provided data on the appearance and extent of competence, the location of the normal inductor, the time during gastrulation at which the inductor acts, and the presence of similar inductors in regenerating tissue. These results make up the bulk of the various reports, but it is the effect of the embryonic grafts on the regenerating tissue which now requires brief comment.

It now appears that the effect of embryonic transplants on blastema mesenchyme is not as great as was at first believed. In the first of the blastema studies referred to above the presumptive medulla from the neurula stage was grafted into regenerating tissue, and in some cases (11 per cent) a small vesicle was formed from the blastema tissue next to the embryonic medulla. Since these vesicles were about the same size and shape as an early ear vesicle, were composed of a single layer of cells, and were situated just adjacent to the transplanted medulla, they were interpreted as probably an abortive attempt on the part of the blastema tissue to form an ear vesicle. However, it was emphasized that none of these vesicles ever developed an endolymphatic duct, or sensory and nonsensory areas, and that the method of formation of the vesicles from the blastema tissue was entirely different from the normal formation of an ear. Hence, these vesicles were described as structures similar to ear vesicles, but not definitely identifiable as such.

In the five extensive subsequent reports on embryonic grafts in regenerating tissue and in several unpublished studies, many different embryonic inductors were grafted into the blastema. These include the eyecup, and all regions of the roof of the archenteron of the late gastrula and of the early neurula (unpublished). Several hundred such transplants have been studied, and in no case is there any indication of a definite inductive action of the embryonic inductor on the regenerating tissue. To test this question further, a series of grafts was made of the dorsal lip of the early and middle gastrula into the blastema (unpublished). Although this is perhaps the most powerful embryonic inductor known, the regenerating tissue again showed no inductive response.

These results, based on such an abundance of data, suggested that the small vesicles originally found adjacent to the grafted medulla were probably not abortive ear vesicles after all. A restudy of the protocols of the original experiments showed that during the course of the work the method of grafting the embryonic tissue into the blastema was slightly changed. In all cases a thin flap of regenerating tissue was separated in part from the blastema, and the graft placed under this flap. However, at first a small amount of blastema tissue including a part of the regenerating notochord, was cut out and discarded in order to make room for the graft. During the course of the work, however, it was found that better results followed merely making the blastema flap, without removing any regenerating tissue. The small vesicles adjacent to the grafted medullas all appeared in the first experiments made, in which the regenerating notochord was purposely somewhat injured during operation. It seemed possible, therefore, that the host filum terminale was also injured during operation and that occasionally a small section of the growing filum was separated from the rest of the filum, forming a small vesicle.

To test this possibility a series of control operations was recently performed in which a blastema flap was made and a small portion of the regenerating notochord and adjacent mesenchyme removed, but no embryonic tissue was transplanted beneath the flap. In three of the four cases studied, the host filum terminale was definitely affected by the operation. A partial twinning

the filum occurred, so that a short extra spur of filum tissue was present at the point of original injury. This short branch is histologically identical with the small vesicles hitherto interpreted as probably abortive ear vesicles. Moreover, the branch of the filum is morphologically identical with the vesicles previously described, except that the vesicles were not attached at any point to the host filum. In a large series of well over 100 experiments it seems clear that occasionally a small amount of filum tissue might be separated from the rest of the filum and reconstitute itself into a small vesicle.

This is now believed to be the explanation of the formation of small vesicles next to the grafted medullas for the following reasons: It clearly explains the sporadic and infrequent appearance of these vesicles in the original study. It explains the location of the vesicles adjacent to the medulla, since the grafts were purposely placed immediately adjacent to the injured notochord and filum. The method of formation of the vesicles, described in detail in the original report, is just what would be expected according to this explanation, whereas it is entirely different from the normal development of an ear vesicle. The histology of the wall of the small vesicles is identical with that of the wall of the filum terminale, even down to small cytological details. Finally, the results are now brought in line with all the subsequent blastema studies, which showed that blastema mesenchyme does not react morphogenically to such embryonic inductors as the eyecup, archenteron roof, or dorsal lip of the blastopore. It is concluded, therefore, that although induction is undoubtedly concerned in regeneration as well as in embryonic development, no specific inductive response by regenerating tissue to an embryonic inductor has yet been shown. On the other hand, the reciprocal effect, the inductive action of regenerating upon embryonic tissue, seems to have been clearly demonstrated.

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Mustard Gas Mutations in *Neurospora*

The production of mutations in *Drosophila* by treatment with mustard gas has been reported by Auerbach and Robson (*Nature, Lond.*, 1946, **157**, 302). (See also Gilman and Philips. *Science*, 1946, **103**, 409.) In view of the great potential significance of this discovery we have carried out an experiment designed to test the effectiveness of mustard gas in inducing mutations in *Neurospora*, with the results reported below.

Asexual spores of wild-type stock 1A of *Neurospora crassa* were placed in the side arm of a sterile Thunberg tube, and two drops of β,β′-dichlorodiethylsulfide (mustard gas) were placed in the main compartment. The tube was closed at atmospheric pressure and immersed in a constant temperature bath at 29° C. At the end of 30 minutes the spores were removed, suspended in sterile water, and applied to protoperithecia of wild-type strain E5297a. As a control, the same cross was made with untreated spores. Following sexual fusion and the development of ripe perithecia, single ascospores were isolated on "complete" medium for germination (Beadle and Tatum. *Amer. J. Bot.*, 1945, **32**, 678). The isolation of only one ascospore from each perithecium insures that each mutation will be counted only once. The cultures were first examined for morphological (*i.e.* visible) variants and then were tested for biochemical mutations by the method of Beadle and Tatum (*loc. cit.*).

In the treated series, 760 spores germinated. Of these, 29, or 3.8 per cent, were mutants. In the control series, 769 spores germinated, of which one, or 0.13 per cent, was classified as a doubtful mutant. This spore germinated but grew so poorly on the complete medium that it could not be tested further.

The 29 mutants resulting from the treatment included 17 visible and 12 biochemical mutants. The visibles, together with the number of independent occurrences of each, were as follows: albino, 1; pink, 2; surface-growing types, 6; cauliflower types, 4; plumose, 1; crew cut, 3. Among the biochemical mutants, strains unable to synthesize the following substances occurred with the frequencies indicated: methionine, 4; cystine and methionine, 2; leucine, 1; adenine, 1; *p*-aminobenzoic acid, 2; thiamin, 1; unidentified amino acids, 1. Growth of each biochemical mutant takes place when the basal medium is supplemented with the substance it cannot synthesize but not on unsupplemented basal medium.

The frequency of mutant spores found in the treated series compares favorably with that obtained following irradiation with ultraviolet light (Beadle and Tatum, *loc. cit.*). The actual mutation rate is close to twice the percentage of mutants found, or about 7.6 per cent for the treated series. This is because the probability of choosing a mutant spore from a perithecium carrying a mutant gene is 0.5 when only one spore is isolated per perithecium. If the perithecium carries more than one mutant gene, the probability of recovering them in a single spore depends on the degree of linkage between the genes. We have not attempted to determine the maximum mutation rate attainable with mustard gas. It is possible that by varying the exposure time or other conditions a higher rate than that reported here might be obtained. In *Drosophila*, Auerbach and Robson found the frequency of sex-linked lethals to run as high as 24 per cent.

At least one of the mustard gas mutants appears to be of a new type. This is the "albino," which is not a true albino but has a yellow tint. This form has not been encountered previously in this laboratory. No new kinds of growth-factor requirements were positively identified among the biochemical mutants. The strain requiring unidentified amino acids responds to casein hydrolysate and to a synthetic mixture of the 10 "essential" amino acids but not to any single amino acid. The minimum number of amino acids required by this mutant has not yet been worked out. It does not grow on a mixture of isoleucine and valine, shown by Bonner, *et al.* (*Arch. Biochem.*, 1943, **3**, 71) to be required by one *Neurospora* mutant. This strain cannot

be regarded as a new type until its growth-factor requirements and the number of genes involved are definitely known. The possibility exists that further studies on the other biochemical mutants listed will show that new genes controlling these syntheses are mutated.

The preponderance of mutants which are unable to synthesize methionine (50 per cent of all the biochemical mutants) is not a unique result of mustard gas treatment, since this class is also the most frequent among radiation-induced mutations.

This work was supported by a grant from the Rockefeller Foundation. We are indebted to Prof. C. R. Noller, Chemistry Department, Stanford University, for the mustard gas used in these experiments.

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Book Reviews

***Human embryology** (prenatal development of form and function)*. W. J. Hamilton, J. D. Boyd, and H. W. Mossman. Baltimore, Md.: Williams and Wilkins, 1945. Pp. viii + 366. (Illustrated.) $7.00.

The objective of the authors of this book has been to present a thorough study of the fundamental morphological and physiological aspects of development of the human embryo and to show their relation to the changes occurring in the mother during pregnancy. Many new facts of development uncovered during the past 20 years have been incorporated in the volume along with modern theoretical interpretations suggested by the work of experimental embryologists. The book is intended primarily for medical students and hence its chief emphasis is on the human embryo.

The opening chapters are concerned with introductory concepts, such as the meaning and scope of the processes involved in embryonic development and the details of structure and formation of the germ cells. As an introduction to the subject proper, there is a detailed account of the cyclic changes in the female genital tract as related to the function of reproduction. In particular, the ovarian and menstrual cycles are discussed in relation to the endocrines controlling them.

Early development, including fertilization, cleavage, and formation of the blastocyst, is dealt with as fully as possible on the basis of information gained from the study of the Macacus and certain other mammals. A very extensive tabulation, accompanied by valuable descriptions of the earliest known human embryos, shows the great advance in this particular field in recent years. Some 50 embryos are listed. Similarly, a thorough discussion of implantation and formation of the fetal membranes has been given. The anatomy and physiology of the placenta are explained as well as the mechanism for the maintenance and termination of pregnancy. Further details of the development of the germ layers and the growth and early development of body form are presented on the basis of the early stages mentioned above and from material made available by the Carnegie Institution of Washington.

In the chapters on organogeny which follow, the subject matter has been most thoroughly and carefully presented. These chapters are well documented, and important references are listed. Tabular summaries, of great value to the student, have been utilized frequently. While some attention is given to anomalous conditions arising during development, this phase of the study is not overdone.

Throughout the book at appropriate places the authors have introduced discussions of the modern theoretical concepts of determination, differentiation, and the role of the organizer stemming from the important work of the experimental embryologists, from the early studies of Roux and Driesch to those of such modern investigators as Spemann and Vogt. These would probably be more profitable to the student if a more extensive background of comparative embryology were provided. Recognizing this fact, the authors have incorporated a brief outline (20 pp.) of comparative embryology emphasizing the earliest stages of development. About half of this outline is devoted to the subject of placentation in various mammals. The apparent inadequacy of this portion of the book is compensated for, however, by the excellence of the rest of the volume.

Although the book conforms to wartime standards of compactness, there is throughout a lavish use of colored figures. For some unknown reason the legends for many of these illustrations are printed in such small type that they are often difficult to read. American readers will also note the use of certain terms in the text which, though frequently employed in England, are not so commonly used in this country.

Mistakes and inaccuracies have been kept to a minimum throughout. In general, this book represents a valuable contribution to the field of human embryology and is remarkably complete and up to date.

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Preventive medicine and public health. **Wilson G. Smillie. New York: Macmillan, 1946. Pp. xvi + 607. (Illustrated.) $6.00.**

Among teachers of the preventive, community, and public health aspects of medicine there are few who have been satisfied with the texts available in the field. Most of the members of this group will welcome this new work by Smillie. The book is so well planned and has such content that the graduate, too, will gain from it an appreciation of the import of these concepts of medicine in his own practice.

Too frequently these aspects of medicine have been presented in the curriculum as subjects quite apart from medicine per se—as distinct courses, related to and recognized as parts of medicine in the broader concept but looked upon by teachers and even by other members of the faculty and students as special fields in themselves. Obviously, this viewpoint is untenable. The medical services of the military forces, during World War II and before, demonstrated the importance and effectiveness of the preventive viewpoint as a part of medicine and as of equal import with the curative viewpoint. Although not new, the concept of correlation and coordination of the preventive and public health aspects with the clinical aspects of medicine, emphasizing these and epidemiologic knowledge concurrently with instruction in history taking, physical examination, laboratory studies, diagnosis, therapy, and prognosis, is a principle operative in but few American centers in medical education. Smillie's new work, however, provides the teacher with a textbook which will permit the teaching of the preventive, community, and public health areas in close relation to the clinical areas of medicine, utilizing the same methods. The student will find in this book individual case histories and epidemiologic analyses of outbreaks of communicable disease and thus may widen his perspective beyond the communicable diseases to include nutritional deficiency states, mental affections, metabolic disturbances, neoplastic diseases, etc. Through the material presented he may acquire a working knowledge that will enable him better to meet his responsibilities and to take advantage of his opportunities in the community.

The plan of the book is excellent. From an introductory section dealing with general concepts, population, and quantitative methods used in medicine, the subject is developed to include sections on environmental factors, communicable diseases and methods used in attempts at their control, child and adult health problems, and public health administration. The content is presented in a style permitting of easy reading, the thesis being developed in logical sequence. More careful editing would, however, have improved the text definitely. In spite of wartime restrictions, the publishers have produced an interesting and attractive publication for which they and the author need make no apologies.

From the adverse viewpoint, this reviewer was disappointed to find certain avoidable inaccuracies, some of them recurring frequently, and the occasional use of older terminology and of terms in ways that might serve to produce erroneous impressions. For example, the terms "death rate," "mortality rate," and "case fatality rate" are used interchangeably, even to expressing the "death rate" and the "mortality rate" in per cent; "trichinosis" is used for trichiniasis, or, preferably, trichinelliasis; and such statements as the following are made: "Diphtheria is caused by the Klebs-Loeffler bacillus" (p. 216); "Serum . . . may agglutinate suspensions of both B. tularensis and B. abortus" (p. 134); ". . . insects such as ticks" (pp. 152, 183); "Large cities are now virtually immune (to milk-borne disease) because of universal pasteurization ordinances" (p. 129).

Notwithstanding these and other editorial deviations of greater or less import, however, it is emphasized that in this reviewer's opinion the book is a splendid addition to the armamentarium of the student of medicine, be he graduate or undergraduate, generalist or specialist, and should find profitable use on a wide scale. Those engaged in the teaching of the preventive, community, and public health aspects of medicine owe a great deal to Dr. Smillie for this, his latest contribution.

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The Indians of the Southeastern United States. **John R. Swanton. (Smithsonian Institution, Bureau of American Ethnology Bull. 137.) Washington, D. C.: Government Printing Office, 1946. Pp. xiii + 943. (Illustrated.) $2.75.**

The present monograph is a capstone crowning the structure of historical ethnology that Dr. Swanton has built for the North American Indian Southeast. It culminates more than 40 years of anthropological field work and library research, well over 30 of which have been devoted to the area which has come to be so largely identified with this scientist. In size of volume, geographical area covered, and range of problems considered, this is his most extensive study. It completes the history and ethnology of the area begun in 1911 with his first major southeastern monograph, *Indian tribes of the lower Mississippi.*

Swanton joined the Bureau of American Ethnology at the turn of the century; his first publication carrying the imprint of the Bureau was in 1905; he published his first paper on southeastern ethnology in 1907. Since this date his bibliography includes over 100 monographs and articles (exclusive of reviews, obituaries, and similar brief pieces), approximately three-fourths of which deal with the Southeast. Some 30 of the southeastern studies, in addition to several of his Northwest Coast and more general papers, are Smithsonian publications. Not only at the Smithsonian but also among American anthropologists in general, his name has become virtually synonymous with southeastern ethnology. It is, in fact, doubtful if another person in American anthropology has made as large a singlehanded contribution to the history and ethnology of a culture area of aboriginal America.

The present volume is in the same scrupulously exact, meticuously detailed, cautiously inductive historical tradition of its major predecessors. It reveals the author's

creative qualities for capturing the historical past: a controlled and critical ethnohistorical imagination, an unrivaled ability to extract ethnological juice from early nonethnological sources, and an almost uncanny flair for plausible if unverifiable toponymic identifications. At the same time, on the more critical side, it shows his judicious evaluation of the extravagant ethnographic description and exaggerated population estimates so characteristic of contemporary narrators. In perhaps no other culture area of native America north of Mexico is such critical capacity more necessary. Like its predecessors also, this study combines the ethnology of the early historical writers with materials, including the author's own notes, gathered by more recent field workers.

This volume, however, departs from its author's preceding papers in several respects. Nearly half of the text (pp. 242–629) describes material culture, a topic disproportionately treated in earlier efforts. The southeastern ethnological picture thus becomes better balanced and more fully rounded. On the other hand, discussions of linguistic classification and population are considerably contracted, doubtless owing to the author's more complete treatments of these subjects elsewhere. Conforming with the universal tendency toward reduction of stocks, the linguistic classification now offered revises certain earlier statements. The author now finds six linguistic families within the "primary" area (Muskhogean, Tunican, Siouan, Caddoan, Iroquoian, and Yuchi). The Algonkian group of culture bearers is considered marginal to the Southeast proper, emerging from a "clearly different culture center" (p. 242), having "developed a somewhat independent pattern" (p. 10). It is, however, included within the "expanded boundaries of the Southeastern cultural province" (Map 1), and the material cultural résumé contains, for the first time in Swanton's writings, extensive discussions of Virginia and Carolina Algonkian traits and complexes.

A large and useful section (pp. 81–219) is devoted to brief sketches of over 170 tribes, tribal groups, and confederations of the "extended" area. These synopses, varying from a few lines to several pages per tribe, succinctly discuss the location, population, principal towns, political affiliations, and contact history of each group. They are done in a modernized *Handbook of American Indians* manner, though without the latter's detailed bibliographical citations. The unusually complete and excellent topically arranged index is quite adequate for towns, tribes, and culture groups, but a tribal synonymy for the Southeast is still badly needed. In the meantime this unusual section of Swanton's monograph will serve as the indispensable reference.

A 170-page section on "Societal and Ceremonial Life" augments the author's previous papers on the nonmaterial culture of the Southeast. Introductory chapters briefly describe the geography of the area and rather boldly relate aboriginal population and culture to the natural divisions. A striking departure from the author's previous rather close commitment to North America is a comparison of the North American Southeast with "corresponding" southeastern areas in South America, Asia, Africa, and Australia (pp. 7, 9, 823–827). In addition, there is a Swantonianly succinct section (pp. 21–81) on the complicated history of the entire area. This summary of prehistoric migrations, historic tribal movements, and native-white relations in general adequately covers developments to the end of the westward removal. Two short paragraphs bring the general situation down to date, but one misses a comparably detailed treatment of the postremoval period, with information as to the current locations, numbers, and cultural status of the surviving groups. The section as a whole is a masterly collation of tribal traditional, linguistic distributional and historical documentary data, and frequently suggests what should be fruitful leads for archeological investigation.

A concluding section (pp. 799–827) considers the area's aboriginal cultures from the point of view of their common characteristics and local specializations. Subareas are basically linguistic, with "constant difficulty" experienced in drawing more inclusively cultural boundaries. Tribal cultures of the area are considered "basically the same," with minor variations in material culture and larger ones in social, political, and religious life interpreted as due to natural environmental differences, importations from specific outside sources, and peculiarities of tribal origins and early historic associations. The so-called "Southeastern Algonkian" are seen as southeasternized northerners; the Algonkian Michigamea and Siouan Quapaw are considered culturally as well as geographically marginal at the area's northwestern corner, and toward the west the Southeast province is described as abruptly ending with the Caddo and Chitimacha. In spite of lack of cultural shading toward the southwest and the decided southeastern rather than Antillean orientation of the Florida tribes, it is claimed that the "great underlying cultural factors" of the Southeast "belong clearly" to Middle America and Peru. "Southeastern culture is an outlier of the culture there. It is a suburb of the American (cultural) capitol." Though these relational interpretations are not copiously culturally documented in this monograph, one feels that few students are better prepared to make them than Swanton and that his conclusions will doubtlessly be largely accepted by the majority of his colleagues.

One never knows when an unsuspected historical manuscript or further field work, even among remnantal peoples, will add to ethnographic data in hand or materially modify accepted ethnological interpretations. However, one closes the present study sharing the opinion of the author that, though students of culture "still have work to do" in the Southeast, the future study of the Indian inhabitants of this area almost surely must "rest mainly with the archeologists." The author's reason for this conclusion, of course, is that he sees few unused nonarcheological resources on the horizon; the reader's reason must be that this is because Swanton has already erected his monument.

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